INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 05 Issue 02 February 2022

DOI: 10.47191/ijmra/v5-i2-37, Impact Factor: 6.072

Page No. 488-494

Experimental Study of Static-Dynamic Stretching and Muscle Strength and Its Effect on the Flexibility of Athletes in Gymnastics

Synta Kusuma Wardani[1], Sigit Nugroho[2], Amri Hartanto[3], Betrix Teofa Perkasa Wibafiet Billy Yachsie[4], Andrian Rahman Ayudi[5], Afeb Chesa Arianto[6], Ujang Nurdin[7]

[1,2,3,4,5,6,7]Department of Sport Science, Yogyakarta State University, Yogyakarta Indonesia

ABSTRACT: The research objectives were to analyze: the effectiveness of static and dynamic stretching exercises for increasing flexibility; the effect of high and low muscle strength abilities on the flexibility of gymnastics athletes; and the interaction of the two types of exercise to increase flexibility in terms of muscle strength. The research method is a 2 x 2 factorial design experiment. The treatment is carried out for 18 times with 2 sets x 30s x 13 exercises, tr.ti: 90s: 2-3 minutes. The population as well as the sample, namely the rhythmic gymnastics athletes of Surakarta City, amounted to 20 people. The instruments used are back dynamometer and sit and reach. Two way ANOVA data analysis technique. The results showed that static stretching exercises had a better effect than dynamic stretching on flexibility in gymnastics athletes. Athletes with high muscle strength abilities were better than low muscle strength athletes with respect to flexibility. Static stretching is suitable for athletes with high muscle strength and dynamic stretching with low strength abilities.

KEYWORDS: Static Stretching, Dynamic, Back Muscle Strength, Flexibility.

INTRODUCTION

One of the gymnastic groups is rhythmic gymnastics. Rhythmic gymnastics is defined as the perfect combination of sport and art by the National Australian Governing Body (Zaccagni et al., 2019). Rhythmic gymnastics is the only gymnastics specifically for female athletes that combines aspects of flexibility, endurance, strength, speed, accuracy, and beauty that are displayed in the form of freehand choreographies (without tools) or with tools (balls, hoops, ropes, ribbons, etc.) and mace) accompanied by music(Soenyoto, 2014).

The problem that attracts attention occurs in the Surakarta City Rhythmic Gymnastics Club, which has a declining performance. In the first championship, namely the 2018 SD O2SN, they managed to get third place, the next championship, namely the 2018 Provincial Championship (Kejurprov) managed to get the first place for the hoop tool, the second place for the mace and the third place for the versatile tool. The next Provincial Popda Championship in 2019 managed to get first place for rope tools and second place for rope tools, the championship which decreased drastically was the 2019 Provincial Championship (Kejurprov) only getting third place. The results of observations in August 2020 at the Surakarta City Persani Gymnastics Club found that, (1) the performance of rhythmic gymnastics athletes in Surakarta tends to decrease resulting in a decrease in achievement from the first championship to the last championship. (2) Surakarta City rhythmic gymnastics athletes have poor muscle strength because they are not stable when using the circuit/choreo apparatus in each exercise. The average muscle strength of the Surakarta City rhythmic gymnastics athletes is 56.30 kg which is in the less category. (3) Surakarta City rhythmic gymnastics athletes have poor flexibility.

The importance of flexibility in rhythmic gymnastics is revealedSantos et al., (2015)that muscle flexibility in rhythmic gymnastics is the main component that must be possessed. clarifiedDas et al., (2018)that flexibility is very important for gymnasts, because basically the majority of talented athletes are impossible to achieve maximum performance if they are gymnast is not flexible enough. Maximum exercise performance can be produced if you have good flexibility. Other opinion according toSleeper et al., (2012)that speed, strength, endurance, agility, flexibility, balance are all physical abilities that play a role in the success of a competitive gymnast and are related to the ability to maintain injury-free participation in gymnastics.

It should be noted that choosing a training method to help smooth the training process is very strategic for a trainer so that training material can be conveyed in the field. This is so that the training process is more interesting and fun, so that the training

objectives can be achieved. Stretching exercises are considered to be important effectors of joint flexibility. Stretching exercises add biomechanical precision to the athlete's movement while offering the opportunity to perform at maximum force throughout the entire range of motion(Alipasali et al., 2019). Static and dynamic stretching exercises are two stretching techniques that are generally recommended to improve flexibility(Yamauchi et al., 2016).

Stretching will improve neuromuscular function and can also cause post-activation potentiation, which is a temporary increase in muscle work resulting from previous contractions. Improved performance through this results in more cross-bridges being formed leading to increased muscle strength production(Behm & Chaouachi, 2011). When following dynamic stretching exercises new muscle fibers are produced, with parallel sarcomere formations. It should be noted, however, that the increased flexibility associated with muscle lengthening has an additional effect on muscle performance(Medeiros & Lima, 2017).

So far, stretching is only used as a prefix to improve the condition of the body before training, but stretching if the right dose can increase the flexibility of athletes. There is no real evidence that stretching before exercise automatically increases the risk of injury. Over the past decade, recent recommendations have evolved, emphasizing the practice of dynamic stretching over static stretching. In addition, research that proves the suitability of static and dynamic stretching exercise models to be given to athletes in terms of muscle strength has never been done.

Several studies examining the effect of stretching on flexibility report conflicting results(Dalrymple et al., 2010);(Amiri-Khorasani et al., 2011). Studies conductedDalrymple et al., (2010);Morrin & Redding (2013)found that static stretching exercises had a greater improvement than dynamic stretching exercises on dancers' flexibility. Other studies byBlazevich et al., (2018);Reid et al., (2018);Micheo et al., (2012);Chaabene et al., (2019)recommends that short-duration static stretching be included as a warm-up component prior to the use of sporting activities has a positive effect on flexibility and prevention of musculotendinous injury, and may increase joint range of motion (ROM).(Behm et al., 2016). These results recommend static stretching exercises rather than dynamic stretching for flexibility.

Different results in studies(Amiri-Khorasani et al., 2011)reported that professional soccer players performed better after dynamic stretching exercises.Chatzopoulos et al., (2019)reported that dynamic stretching was significantly better in increasing flexibility and movement time than static stretching. Dynamic stretching five times per week for a total of 4 weeks appears to increase running time as a result of dynamic muscle lengthening and improved coordination, and to reuse of stretching energy.(Behm et al., 2016), dynamic stretching for 8 weeks can not only improve flexibility but also jump power measurement(Turkey-Belkhiria et al., 2014), two sets of dynamic stretches have shown a similarly significant increase in 20-m . running speed(Turkey et al., 2012).

One that affects flexibility is the quality of the muscles in this case strength. It is as in opinionBudiwanto, (2012)states the factors that affect joint flexibility, namely muscle strength. Strong muscles will make daily muscle work efficient and will make your body shape better(Agusrianto & Rantesigi, 2020).

It seems that contradictory and constantly changing reports regarding research into the effectiveness of dynamic or static stretching can cause confusion, especially with trainers. More research is needed to determine whether dynamic or static stretching is more appropriate for increasing flexibility. Both types of stretching exercises have their advantages and disadvantages. Therefore, the aim of this review is to further examine its impact on athlete flexibility in relation to muscle strength.

METHODS

The research method used is a two x two factorial design experiment. The time for the research was two months, starting from December 9, 2020 to January 22, 2021. The population and also the sample involved were the rhythmic gymnastics athletes of Surakarta City, totaling 38 athletes. Sampling technique is based on theory(Miller, 2008), which is determined by 27% of the upper group and 27% of the lower group from the test results. Based on this, 20 athletes were obtained. The sample selection was based on these criteria so that there was a fairly high gap between the high and low power groups, while the medium group was not trained to use the applied treatment.

Then from each of the data divided into two groups by means of ordinal pairing and obtained each 5 athletes with high muscle strength were treated with static and dynamic stretching exercises, the same was also done for group of athletes who have low muscle strength. Sample grouping in Table 1:

Table 1. Sample Grouping

Muscle Strength (B)	Stretching Exercises (A)	
	Static (A1)	Dynamic (A2)
Height (B1)	5 athletes	5 athletes
Low (B2)	5 athletes	5 athletes

The research process was carried out for 18 treatments. Training is carried out 3 times a week regularly for 6 weeks. The treatment for static and dynamic stretching groups is 2 x 30s x 13 exercises, tr.ti: 90s: 2-3 minutes. The instrument used to measure the strength of the back muscles is the back dynamometer. This test has a validity coefficient of 0.85, while the reliability coefficient is 0.89 (Sepdanius et al., 2019). The instrument for measuring flexibility uses sit and reach, with a validity of 0.978 and a reliability of 0.989 (Sepdanius et al., 2019). Data analysis used two-way ANOVA, with assumption test, namely normality and homogeneity test. Next, analyze the Post Hoc p test. 5%.

RESEARCH RESULTS

The sample in this study was the Woodball Club in Bantul Regency which consisted of 3 clubs, namely Mustang Woodball Club, The descriptive statistics of the pretest and posttest flexibility are presented in full below:

Table 2. Overall Descriptive Statistics

Practice Group	Muscle Strength	Pretest	Posttest
Static Stretch	Height (A1B1)	18.04	22.28
	Low (A1B2)	17.90	20.32
Dynamic Stretch	Height (A2B1)	15.82	17.94
	Low (A2B2)	15.78	18.26

Based on Table 2, it shows that the flexibility of group A1B1 (athletes with high muscle strength in static stretching exercises) has an average pretest of 18.04 cm, increased after being given static stretching exercises at the time of posttest by 22.28 cm, group A2B1 (athletes with strength high muscle dynamic stretching exercise) the average pretest was 17.90 cm, increased after being given posttest dynamic stretching exercise was 20.32 cm, group A1B2 (athletes with low muscle strength static stretching exercise) the average pretest was 15.82 cm , increased after being given static stretching exercises at the posttest by 17.94 cm, the A2B2 group (athletes with low muscle strength in dynamic stretching exercises) the average pretest was 17.78 cm, increased after being given static stretching exercises at the posttest by 18,26 cm.

Normality test

Shapiro-Wilk was used to analyze the data normality test. A summary of the Shapiro-Wilk analysis is presented in full below:

Table 3. **Normality test**

Group	Significance
Initial Data Flexibility Group A1B1	0.539
Final Data Flexibility Group A1B1	0.823
Initial Data Flexibility Group A2B1	0.635
Final Data Flexibility Group A2B1	0.787
Initial Data Flexibility Group A1B2	0.515
Final Data Flexibility Group A1B2	0.982
Initial Data Flexibility Group A2B2	0.971
Final Data Flexibility Group A2B2	0.794

The results in Table 3 show the analysis of the results of the normality test of the flexibility pretest and posttest data from the static and dynamic stretching exercise groups, the Shapiro-Wilk coefficient is greater than 5%, so that the data for all groups are normally distributed.

Homogeneity Test

The homogeneity test was carried out using the Levene Test. The summary of the Levene Test test analysis is presented in full below:

Table 4. Homogeneity Test

Group	Significance
Initial Data Flexibility- Final Data Flexibility	0.707

The results in Table 4, the calculation results obtained a significance value of 0.707 greater than 5%. Thus the population has the same variance or homogeneous.

Hypothesis Test Results

Hypothesis analysis to answer the research results is based on the interpretation of the results of a two-way ANOVA. Hypothesis analysis is presented in full below:

Table 5. ANOVA test

Source	F	Sig.	Description
Exercise Method	5.525	0.032	Significant
Muscle Strength	10,999	0.004	Significant
Exercise Method * Muscle Strength	12.318	0.003	Significant

Hypothesis 1 obtained a calculated F value of 5.525 and a significance of 0.032 < 5%, the basis shows H1 "Static stretching exercise has a significantly different effect than dynamic exercise on increasing flexibility", is accepted. Based on the results of the analysis, it turns out that the static stretching exercise method group got an average difference of 3.18 cm, better than the dynamic stretching exercise method group of 2.45 cm with a posttest average difference between the two static and dynamic stretching groups of 0.73 cm.

Hypothesis 2 obtained F count 10.999 and significance 0.004 < 5%, the basis shows H2 "The ability of athletes who have high and low muscle strength abilities has a significant difference in flexibility in gymnastics athletes", is accepted. Based on the results of the analysis, it turns out that athletes who have high muscle strength with an average difference of 3.33 cm are higher than athletes with low muscle strength of 2.30 cm, the difference in the posttest average of high muscle strength groups with low muscle strength is 1 ,03 cm.

Hypothesis 3 obtained a calculated F value of 12,318 and a significance of 0.003 < 5%, the basis shows H3 "Static stretching and dynamic stretching exercises have a significant interaction with high and low muscle strength in increasing flexibility in gymnastics athletes", accepted. The graph of the interaction test results between exercise (static and dynamic stretching) and high muscle strength and low muscle strength on flexibility is presented more fully in the following figure:

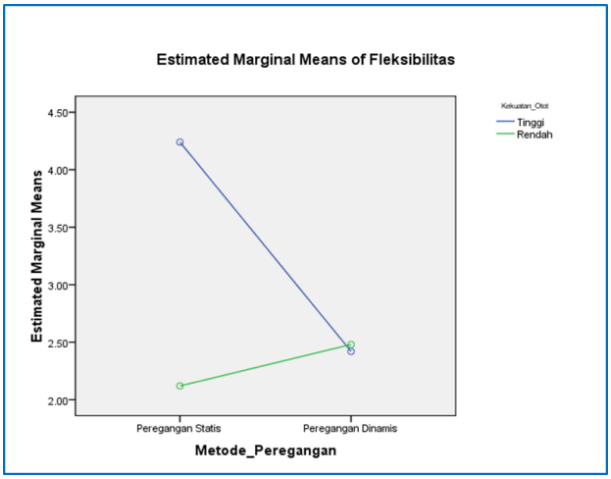

Figure 1.Interaction Result Graph

DISCUSSION

Hypothesis 1

Based on hypothesis testing, it is known that the static stretching exercise method and the dynamic stretching exercise method have a significant effect on flexibility in gymnastics athletes in Surakarta City. The results of the analysis prove that the static stretching exercise method is more significant in increasing flexibility than dynamic exercise. The results of studies comparing

cyclic stretching (ballistic and dynamic) with static stretching (standard) varied. For example,Coons et al., (2017)reported that both dynamic ROM and static stretching significantly increased hamstring flexibility and that static stretching was twice as effective in increasing hamstring flexibility as dynamic ROM exercises. Improvements in muscle strength, jump height, and agility were found after dynamic stretching(Zhang et al., 2018). Dynamic stretching exercises in the form of kicks can improve the performance of the quadriceps and hamstring muscles in terms of average strength and are beneficial for athletes when performed before activity.(Freund et al., 2016). The combined use of static and dynamic stretching has the potential to improve standing balance(Takeda et al., 2020).Perrier et al., (2011)compared the effects of static and dynamic stretching on sitting flexibility and range and unlike this study found no difference in sitting scores and range between the static and dynamic treatments. Other studiesAmiri-Khorasani et al., (2011),Perrier et al., (2011),Samukawa et al., (2011)have shown that dynamic stretching can produce equal or greater results in both dynamic and static ROM tests. Dynamic stretching improves repetitive sprint performance to a higher level than static stretching and no stretching(Zmijewski et al., 2020).

Different results in studiesMondam, (2017),Fjerstad et al., (2018)that static stretching exercises have a positive impact on joint range of motion, sensitivity of the Golgi tendon organs(Torres et al., 2012). The hamstring muscles have been shown to improve after dynamic stretching exercises(Sozbir et al., 2016). The advantages of static stretching exercises to increase static ROM are in accordance with a number of other studies. Increased joint range of motion (Werstein & Lund, 2012)and reduce muscle-tendon stiffness (Akagi & Takahashi, 2013)observed after static stretching exercise. Likewise, reductions in muscle strength, energy expenditure, and performance were associated with a person after performing static stretching exercises (Van Gelder & Bartz, 2011). In contrast, improvements in muscle strength, jump height, and agility were found after dynamic stretching exercises. Repeated muscle contractions during dynamic exercise increase muscle temperature, and this can decrease resistance, leading to increased muscle extensibility. On the other hand, acute improvement after static stretching is associated with increased tolerance to stretching or changes in the mechanical properties of muscle tendon units (i.e., reduced muscle stiffness).(Opplert & Babault, 2018). The evidence remains in favor of static stretching for long-term gains in flexibility.

Hypothesis 2

The results of the analysis prove that there is a significant difference between athletes who have high muscle strength and low muscle strength on flexibility in gymnastics athletes in Surakarta City. Athletes who have high muscle strength abilities are better than athletes with low muscle strength abilities. Decreased joint flexibility, influenced by age(Geremia et al., 2015), and also muscle strength(Sukadiyanto & Muluk, 2011).

Hypothesis 3

The results of the analysis prove that the static stretching exercise method is a more effective method to be trained on athletes with high muscle strength abilities, while dynamic stretching is suitable to be trained on athletes with low muscle strength abilities. Static stretching is a movement to stretch the muscles that is carried out slowly until tension occurs and achieves pain due to the pull of the stretched muscle. Static stretching affects nerve activation and produces acute changes in force production; it can also affect the sense of strength(Chatzopoulos et al., 2019). Based on this, athletes who have high muscle strength will be more suitable to do static stretching exercises.

CONCLUSIONS

It can be concluded that static stretching exercises have a better effect than dynamic stretching on flexibility in gymnastics athletes. Athletes with high muscle strength abilities were better than low muscle strength athletes with respect to flexibility. Static stretching is suitable for athletes with high muscle strength and dynamic stretching with low muscle strength abilities.

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